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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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09/865,546

05/29/2001

Taiji Noda

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22204

7590

12/26/2002

NIXON PEABODY, LLP
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EXAMINER

SARKAR, ASOK K

ART UNIT

PAPER NUMBER

2829

DATE MAILED: 12/26/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/865,546

Applicant(s)

NODA, TAIJI

Examiner

Asok K. Sarkar

Art Unit

2829

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 November 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-38 is/are pending in the application.
- 4a) Of the above claim(s) 10-27 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9 and 28-38 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 May 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Response to Arguments

1. Applicant's arguments with respect to claims 1 – 9 and 28 - 38 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 3, 28, 32, 33 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Burr, US 6,093,951.

Regarding claims 1, 3 and 34, Burr teaches a semiconductor device comprising a heavily doped diffusion layer formed (see Fig. 1) by using dopant ion In and Sb of relatively large mass number such as In in column 14, lines 35 – 41 in an epitaxial region of silicon included in at least an upper portion of the epitaxial silicon substrate in column 5, lines 45 – 50 and in column 15, lines 48 – 50.

Burr also teaches a similar device in which the epitaxial layer is formed to form the device elements (source, drain and channel region) with reference to Figs 1 and 2 in column 16, lines 30 – 34. The diffusion layers are inherently shallower than the epitaxial region since they have to be formed in the semiconductor layer.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to form Burr's device alternatively on the epitaxial region of a

Art Unit: 2829

semiconductor surface in which the diffusion layer is shallower than the epitaxial region as taught by Burr.

Regarding claim 28, Burr teaches doping with In at levels of 10^{13} cm^{-2} and over $5 \times 10^{13} \text{ cm}^{-2}$ level with n-type ions such as As and Sb and fails to expressly teach doping with In at dose over $5 \times 10^{13} \text{ cm}^{-2}$.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to form the diffusion layer with In instead of Sb since heavy ions such as In and Sb have smaller diffusion coefficient.

Regarding claims 32 and 33, Burr teaches forming an epitaxial layer on the Si substrate in column 5, lines 45 – 46 to define a channel region. Burr also teaches that source, drain and channel regions can also be formed in the epitaxial region.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to form the epitaxial Si on the Si substrate by modifying the device such that the source, drain and channel regions are all formed in the epitaxial region.

4. Claims 2 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Burr, US 6,093,951 in view of Koyama, US 5,177,569.

Burr teaches implanting In ion as was discussed previously in rejecting claims 1 and 3.

Burr fails to teach epitaxial region having $\langle 110 \rangle$ - oriented zone axis.

Koyama teaches the advantages of dopant implantations in single crystal (110) plane orientation in between column 6, line 63 and column 7, line 24.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to form the diffusion layer in Burr's device with In and replace the substrate having $\langle 110 \rangle$ - oriented zone axis so that the epitaxial layer is formed with $\langle 110 \rangle$ - oriented zone axis since the transistor characteristics will be further enhanced as taught by Koyama in addition to being enhanced by using heavy weight dopant In.

5. Claims 4 – 9, 30, 31 and 35 - 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Admitted prior Art (APA) in view of Burr, US 6,093,951 and Koyama, US 5,177,569.

The APA teaches a MIS device with a gate electrode above a semiconductor substrate, a source/drain diffusion layer of first conductivity type, an extension zone of heavily doped diffusion layer and a pocket region doped with a second conductivity type dopant under the extension zone of heavily doped diffusion layer.

The APA fails to expressly teach heavy doping ($> 5 \times 10^{13} \text{ cm}^{-2}$) by In, extension zone of heavily doped diffusion layer of Sb ion and epitaxial region with $\langle 110 \rangle$ - oriented zone axis.

Burr teaches heavily doped pocket region with In and heavy doped diffusion layer with Sb in an epitaxial region as explained above in rejecting claims 1 and 3.

Koyama teaches the advantage of epitaxial region with $\langle 110 \rangle$ - oriented zone axis as explained above in rejecting claim 2.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify the teachings of APA and build the device by growing an epitaxial region with $\langle 110 \rangle$ - oriented zone axis or use a substrate with $\langle 110 \rangle$ - oriented

Art Unit: 2829

zone axis to grow epitaxial layer as taught by Koyama and use heavily doped pocket and extension regions with ions such as In and Sb of large mass numbers as taught by Burr so that the size and area of the doped regions can be accurately controlled to enhance device performance.

6. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cogan, US 4,476,622 in view of Prabhakar, US 5,869,359.

Cogan teaches a semiconductor device comprising a Si semiconductor substrate 42 on which epitaxial layer 40 of 110 orientation is formed as the main surface with reference to Fig. 1 in column 3, lines 1 – 8. A diffusion layer 44 is formed by doping with As with reference to fig. 1 in column 3, lines 12 – 15.

Cogan teaches n-type dopant such as As but fails to teach dopant of large mass number.

Prabhakar teaches that n-type dopants can be As or Sb in column 5, line 15.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify the teachings to modify Cogan and use Sb in stead of As since Sb will also act as a n-type dopant for Cogan's device.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

8. This application contains claims 10 - 27 drawn to nonelected claims. Please ensure that a complete reply to the final rejection includes **cancellation** of nonelected claims.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 703 308 2521. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kammie Cuneo can be reached on 703 308 1233. The fax phone numbers for the organization where this application or proceeding is assigned are 703 308 7722 for regular communications and 703 308 7722 for After Final communications.


Application/Control Number: 09/865,546

Page 7

Art Unit: 2829

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 4918.

Asok K. Sarkar
December 17, 2002



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